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[List of Attached Documents]

[Name of Document]	Specification	1
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[Name of Document]	Abstract	1
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[Name of Document] Specification

[Title of Invention] LIQUID-CRYSTAL DISPLAY DEVICE AND DRIVING METHOD THEREOF

[What is claimed is]

[Claim 1]

A liquid-crystal display device comprising:

a liquid-crystal display panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and thin-film transistors arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines;

a controller circuit for controlling the source driver and the gate driver; and

a polarity of a voltage applied to each of the pixels being inverted in every set of two or more horizontal synchronizing periods;

wherein the source driver has a resetting means for resetting outputs of the source driver in a blanking period of each of the horizontal synchronizing periods of the set.

[Claim 2]

The device according to claim 1, wherein the resetting means

performs its resetting operation with reference to a latch signal generated by the controller circuit.

[Claim 3]

A liquid-crystal display device comprising:

a liquid-crystal display panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and thin-film transistors arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines;

a controller circuit for controlling the source driver and the gate driver; and

a polarity of a voltage applied to each of the pixels being inverted in every set of two or more horizontal synchronizing periods;

wherein the source driver has a polarity inverting means for inverting the polarity of outputs of the source driver in a blanking period of each of the horizontal synchronizing periods of the set.

[Claim 4]

The device according to claim 3, wherein the polarity inverting means performs its polarity-inverting operation with reference to

a latch signal and a polarity-inverting signal, which are generated by the controller circuit.

[Claim 5]

The device according to one of claims 1 to 4, wherein the device is driven by a 2-H dot inversion method, where the polarity of the voltages applied to the respective pixels is inverted in every signal line and is alternately inverted in every set of the two scanning lines.

[Claim 6]

The device according to claim 3 or 4, wherein the device is driven by a 2-H line inversion method, where the polarity of the voltages applied to the respective pixels is kept the same in every signal line and is alternately inverted in every set of the two scanning lines.

[Claim 7]

A method of driving a liquid-crystal display device, the device comprising:

a liquid-crystal display panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines,

scanning lines, and thin-film transistors arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines;

a controller circuit for controlling the source driver and the gate driver; and

a polarity of a voltage applied to each of the pixels being inverted in every set of two or more horizontal synchronizing periods;

the method comprising:

resetting outputs of the source driver in each of the horizontal synchronizing periods of the set.

[Claim 8]

The method according to claim 7, wherein the resetting the outputs of the source driver is performed with reference to a latch signal generated by the controller circuit in a blanking period of the horizontal synchronizing period.

[Claim 9]

A method of driving a liquid-crystal display device, the device comprising:

a liquid-crystal display panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and thin-film transistors arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines;

a controller circuit for controlling the source driver and the gate driver; and

a polarity of a voltage applied to each of the pixels being inverted in every set of two or more horizontal synchronizing periods;

the method comprising:

inverting the polarity of outputs of the source driver in each of the horizontal synchronizing periods of the set.

[Claim 10]

The method according to claim 9, wherein an operation of inverting the polarity of the outputs of the source driver is performed with reference to a latch signal and a polarity-inverting signal in a blanking period of each of the horizontal synchronizing periods; and

the latch signal and the polarity-inverting signal are generated by the controller circuit.

[Claim 11]

The method according to one of claims 7 to 10, wherein the device is driven by a 2-H dot inversion method, where the polarity

of the voltages applied to the respective pixels is inverted in every signal line and is alternately inverted in every set of the two scanning lines.

[Claim 12]

The method according to claim 9 or 10, wherein the device is driven by a 2-H line inversion method, where the polarity of the voltages applied to the respective pixels is kept the same in every signal line and is alternately inverted in every set of the two scanning lines.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a liquid-crystal display (LCD) device and a driving method thereof. More particularly, the invention relates to a LCD device and a method of driving the device, in which the polarization of the data or signal voltage is inverted in every two or more horizontal synchronization periods.

[0002]

[Prior Art]

In recent years, because of the advantage of thin, light-weight, and low power-consumption, the active-matrix addressing LCD device, which uses Thin-Film Transistors (TFTs) as its switching elements,

has been extensively used as the display device for so-called Office Automation (OA) instruments, mobile terminal equipment, and so on. To prevent the display quality from degrading, the active-matrix addressing LCD device is usually driven by an ac voltage, where the pixel electrodes are repeatedly applied with a positive voltage and a negative voltage in every fixed period with reference to the voltage applied to the opposite electrode.

[0003]

It is ideal that the positive voltage waveform and the negative voltage waveform of the voltage applied across the liquid crystal are symmetrical. However, due to deviation of the common voltage, impurities contained in the liquid crystal cells, and so on, such an ideal voltage waveform as above is unable to be actually applied. Thus, it is usual that the positive effective value and the negative effective value of the voltage are different from each other. As a result, the obtainable optical transmittance of the liquid crystal by the positive effective voltage is different from that by the negative effective voltage, thereby fluctuating the luminance according to the period of the applied ac voltage. Since the LCD device is usually driven by the ac voltage of 60 Hz, the period between a positive peak voltage and a next positive peak voltage is 30 kHz. Thus, if a deviation occurs between the positive and negative amplitudes of the ac voltage, a problem that flickers at 30 Hz will be observed.

[0004]

To suppress such the flicker as above, driving methods such as the "dot inversion method" where the polarity of the applied voltages are inverted among the pixels horizontally and vertically adjacent to each other, and the "line inversion method" where the polarity of the applied voltages are inverted between the horizontal lines vertically adjacent to each other, have ever been developed. In the dot inversion method, as shown in Fig. 7, the polarization of the voltages applied to the individual pixels is inverted in such a way that the combination of the first frame and the second frame is defined as one period. Therefore, even if the effective values of the applied positive and negative voltages within the first and second frames aredifferentfromeachother,theeffectivevaluedifferenceisspatially (areally) cancelled to suppress the 30-Hz flicker. This method has an advantage that high image quality is obtainable, because the fluctuation of the common voltage induced by way of the signal lines is small.

[0005]

The prior-art dot inversion method highly exhibits its flicker canceling effect with respect to a uniform gray image displayed in the whole screen. However, this method scarcely exhibits its effect for some images having specific patterns (e.g., a fixed pattern image displayed in an area where the polarization of the applied voltages to the pixel electrodes is inverted). This means that flicker will be observed because the polarity of the applied voltages is biased

for the images in question. Therefore, the prior-art dot inversion method is weak in displaying a checkered pattern image formed by dots. Because of the same reason, the prior-art line inversion method is weak in displaying a striped pattern image formed by horizontal stripes arranged at every other line (i.e., a border). In this way, with the prior-art dot and line inversion methods, flicker may be observed because the polarity of the applied voltages is biased for the images in question in each frame.

[0006]

These weak images scarcely appear when animation is displayed on the screen. However, a checkered pattern of dots frequently appears in the ending scene of the Microsoft Windows (Registered Trademark) or in images formed by dithering (i.e., areally gradation images). Therefore, these weak images are often observed in the personal computer screen, which raises a problem in some cases.

[0007]

To solve this problem, instead of the above-described prior-art dot and line inversion methods where the polarization inversion of the applied voltages is performed in every horizontal synchronizing period, two improved methods (which will be termed the "2-H inversion methods" hereinafter) where the polarization inversion of the applied voltages is carried out in every two horizontal synchronizing periods have been developed and used. With the "2-H dot inversion method" shown in Fig. 8 and the "2-H line inversion method" shown in Fig.

9, flicker is not observed in the weak checkered pattern appearing in the ending scene of the Windows. Also, the said weak checkered pattern rarely appears in the images formed by dithering. As a result, appearance of the flicker is suppressed more effectively than the above-described prior-art dot and line inversion methods.

[0008]

However, with the above-described 2-H inversion method, the first horizontal line (i.e., the first one of the two horizontal synchronizing periods) includes the charging period for electrically charging the drain lines. Therefore, the total amount of electric charge written into the pixels within the first horizontal synchronizing period is likely to be less than that written into the pixels within the second horizontal synchronizing period, if the length of the charging or writing period is insufficient. The difference of the total amount of written electric charge between the first and second horizontal synchronizing periods induces luminance difference between the said two periods. As a result, a problem that a horizontal stripe appears in every two periods (every two horizontal synchronizing periods) occurs.

[0009]

This problem will be explained below with reference to Fig. 5. Fig. 5 shows a waveform diagram of the output of the H driver (which may be termed the horizontal, source, or row driver) in the prior-art 2-H inversion methods. In Fig. 5, STB denotes the latch pulse for

latching the data from the H driver, VCK denotes the clock pulse, and VOE denotes the enabling pulse for controlling the operation of the writing gates. As shown in Fig. 5, the "writing period" is given by the period from the falling edge of STB to the rising edge of VCK wherein VOE is in its low level. Since the rising or falling part of the output of the H driver is included in the writing period of the first horizontal line, the total amount of the charge written into the respective pixels in the first horizontal line is likely to be less than that written into the respective pixels in the second horizontal line, thereby generating luminance difference between the first and second horizontal lines. As a result, a horizontal stripe is generated between the first and second horizontal lines.

[0010]

Topreventtheformationofthehorizontalstripesintheprior-art 2H inversion methods, for example, there is a method that the writing period is shortened by using VOE, thereby equalizing the total amounts of the written charge in the first and second horizontal lines to each other, a shown in Fig. 6. In the method of Fig. 6, the horizontal stripes can be prevented. However, the writing period is shortened and therefore, there is a problem that the total luminance is likely to be low in the normally black mode LCD panel.

[0011]

The present invention was created in consideration of the above-described problem. A main object of the present invention is

to provide a LCD device that prevents the formation of the horizontal stripes without decreasing the luminance in the 2H or more inversion method, and a method of driving the device.

[0012]

[Means for solving the Problems]

To accomplish the above-described object, a LCD device according to the present invention comprises:

a LCD panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and TFTs arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines; and

a controller circuit for controlling the source driver and the gate driver;

a polarity of a voltage applied to each of the pixels being inverted in every set of two or more horizontal synchronizing periods;

wherein the source driver has a resetting means for resetting the outputs of the source driver in a blanking period of each of the horizontal synchronizing periods of the set. The resetting means may perform its resetting operation with reference to a latch signal generated by the controller circuit.

[0013]

Moreover, another LCD device according to the present invention comprises:

a LCD panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and TFTs arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines; and

a controller circuit for controlling the source driver and the gate driver;

wherein a polarity of a voltage applied to each of the pixels is inverted in every set of two or more horizontal synchronizing periods; and wherein the source driver has a polarity inverting means for inverting the polarity of the outputs of the source driver in a blanking period of each of the horizontal synchronizing periods of the set. The polarity inverting means may perform its polarity-inverting operation with reference to a latch signal and a polarity-inverting signal, which are generated by the controller circuit.

[0014]

With the present invention, it is preferred that the polarity of the voltages supplied by way of the signal lines is alternately

inverted in every signal line and the polarity of the voltages supplied by way of the scanning lines is kept the same in every set of the two scanning lines, thereby driving the device by a 2-H dot inversion method. Alternately, it is preferred that the polarity of the voltages supplied by way of the signal lines is kept the same in every signal line and the polarity of the voltages supplied by way of the scanning lines is kept the same in every set of the two scanning lines, thereby driving the device by a 2-H line inversion method.

[0015]

Furthermore, a method of driving a LCD device according to the present invention, the device comprising:

a LCD panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and TFTs arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines; and

a controller circuit for controlling the source driver and the gate driver;

wherein a polarity of a voltage applied to each of the pixels is inverted in every set of two or more horizontal synchronizing periods;

the method comprises:

resettingtheoutputsofthesourcedriverineachofthehorizontal synchronizing periods of the set. The resetting may be performed with reference to a latch signal generated by the controller circuit in a blanking period of the horizontal synchronizing period.

[0016]

Moreover, another method of driving a LCD device according to the present invention, the device comprising:

a LCD panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and TFTs arranged in respective pixels surrounded by the signal lines and the scanning lines;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines; and

a controller circuit for controlling the source driver and the gate driver;

wherein a polarity of a voltage applied to each of the pixels is inverted in every set of two or more horizontal synchronizing periods;

the method comprises:

inverting the polarity of the outputs of the source driver in each of the horizontal synchronizing periods of the set. The inverting of the polarity of the outputs of the source driver may be performed with reference to a latch signal and a polarity-inverting signal,

both of which are generated by the controller circuit, in a blanking period of each of the horizontal synchronizing periods.

[0017]

Specifically, in the method of driving a LCD device in such a way that the polarity of the outputs of the source driver is kept the same in a set of two or more horizontal synchronizing periods and then, inverted in a next set thereof, the outputs of the source driver are turned to have their middle point voltages between the positive and negative peak values of the respective liquid-crystal driving voltages, or the polarity of the outputs of the source driver is inverted in a blanking period of each of the horizontal synchronizing periods of the set. Thus, the rising condition of the outputs of the source driver in each horizontal line (in each horizontal synchronizing period) is uniformized. As a result, the total amount of the electric charge written into the respective pixels in the first horizontal line is equalized to that in the second horizontal line, thereby preventing the horizontal stripes from appearing on the screen. To turn the outputs of the source driver to the middle point voltage between the positive and negative peak values of the driving voltage, the outputs of the source driver may be reset by electrical short-circuiting the outputs of the source driver in the blanking period. A latch pulse may be used for determining the timing of resetting operation. The invention is applicable to the 2-H or more inversion method.

[0018]

Accordingly, a LCD device is obtained where flicker will not be observed even when weak images such as a checkered pattern of dots are displayed, and where a horizontal stripe will not appear in every two horizontal lines (every two synchronizing periods) when a solid color of a tone is displayed.

[0019]

[Embodiments of the Invention]

In a preferred embodiment of the method of driving a LCD device according to the invention, the device comprising:

a panel including an active-matrix substrate, an opposite substrate, and a liquid crystal sandwiched by the active-matrix substrate and the opposite substrate;

the active-matrix substrate having signal lines, scanning lines, and TFTs;

a source driver for driving the signal lines;

a gate driver for driving the scanning lines; and

a controller circuit for controlling the source driver and the gate driver;

wherein a polarity of a voltage applied to each pixel is inverted in every set of two or more horizontal synchronizing periods;

the method comprises resetting the outputs of the source driver or inverting the polarity of the outputs of the source driver in the blanking period of each of the horizontal synchronizing periods.

In this way, the rising condition of the outputs of the source

driver in each horizontal line (in each horizontal synchronizing period) is uniformized due to the above-described resetting or the polarity inversion. As a result, the horizontal stripes are prevented from appearing.

[0020]

In addition, the wording "resetting the outputs of the source driver" has a meaning that in the state where the resetting function of the source driver is turned on (i.e., activated), electrical short-circuit among all the output pins of the source driver is induced while the latch pulse is in its high level. Thereafter, gray-scale voltages are outputted to the LCD panel in synchronization with the falling edge of the latch pulse. On the other hand, in the state where the resetting function of the source driver is turned off (i.e., inactivated), all the output pins of the source driver are turned to their high-impedance states while the latch pulse is in its high level. Thereafter, gray-scale voltages are outputted to the LCD panel in synchronization with the falling edge of the latch pulse.

[0021]

[Examples]

To explain the above-described embodiments of the invention in more detail, examples of the present invention will be explained below with reference to Figs. 1 to 4. Fig. 1 is a schematic functional block diagram showing the configuration of a LCD device according to an example of the invention. Figs. 2 and 3 are diagrams for comparing

the waveform of the drain voltage in the 2H inversion method according to the example of the invention and that in the prior-art 2H inversion method, respectively. Fig. 4 is a diagram showing the waveforms of the outputs of the H driver in the 2H inversion method according to the example of the invention.

[0022]

As shown in Fig. 1, a LCD panel 11 comprises TFTs 15 as switching elements at the respective intersections of signal lines 18 and scanning lines 17. The scanning lines 17 are connected to the gates of the TFTs 15. The signal lines 18 are connected to the sources of the TFTs 15. The drains of the TFTs 15 are connected to the electrodes of the liquid crystal capacitors 16 constituting the screen. The opposite electrodes of the liquid crystal capacitors 16 are transparent electrodes. When the scanning lines are turned to their high level to cause the corresponding TFTs 15 conducting, predetermined voltages are written into the liquid crystal capacitors 16 connected to the TFTs 15 thus caused conducting by way of the signal lines 18, thereby changing the alignment direction of the liquid crystal molecules. In this way, desired images are displayed.

[0023]

A gate driver 13 is provided at the ends of the scanning lines 17 of the LCD panel 11. A source driver 14 is provided at the ends of the signal lines 18 of the panel 11. The gate driver 13 and the source driver 14 are controlled by a controller circuit 12. The controller

circuit 12 generates control signals for controlling the source driver 14 and the gate driver 13 from a horizontal synchronization signal, a vertical synchronization signal, and image signals. The horizontal synchronization signal, the vertical synchronization signal, and the image signals are inputted from the outside. The source driver 14 and the gate driver 13 are operated in accordance with the control signals and the image signals from the controller circuit 12, thereby displaying images. The source driver 14 has a resetting function of resetting its outputs or a polarity-inverting function of inverting the polarity of its outputs in each horizontal synchronizing period such as the latch pulse period (i.e., the blanking period) at the polarity inversion in every set of the two horizontal synchronizing periods.

[0024]

The operation of the LCD device having such the structure as above will be explained below with reference to Fig. 2. In Fig. 2, STB denotes the latch pulse for latching the data of the source driver 14. The function of the latch pulse STB is to latch the content of the data register in the source driver 14 at the rising edge. If the source driver 14 has not the electric-charge collecting mode, when the latch pulse STB is in its high level, the outputs of the source driver 14 are in the high impedance state. If the source driver 14 has the electric-charge collecting mode, when the latch pulse STB is in its high level, the outputs of the source driver 14 are electrically

short-circuited to be reset only when the polarity pulse POL explained later is switched. Moreover, at the falling edge of the latch pulse STB, the panel voltages, which are to be applied to the LCD panel in each horizontal synchronizing period, are outputted from the source driver 14 to the LCD panel 11. While the latch pulse STB is in its low level, the panel voltages supplied from the source driver 14 are kept being applied to the panel 11.

[0025]

Here, with the structure of the prior-art LCD device, when the drain voltages of the same polarity are written into the pixels in every two or more horizontal synchronization periods, the total amounts of electric charge written into the pixels within the respective horizontal synchronizing periods are likely to be different from each other, thereby inducing luminance difference between the horizontal lines or periods. As a result, horizontal stripes will appear due to the luminance difference. On the other hand, with the invention, in a blanking period of each of the horizontal synchronizing periods of the set, the outputs of the source driver 14 are turned to have middle point voltages between the positive and negative peak values of the liquid-crystal driving voltages, or the polarity of the outputs of the source driver 14 is inverted. To turn the outputs of the source driver 14 to have middle point voltages between the positive and negative peak values of the liquid-crystal driving voltages, the outputs of the source driver 14 may be reset to cause electrical short-circuit

among the outputs of the source driver 14. The resetting of the outputs of the source driver 14 may be conducted with reference to the latch pulse STB. Thus, the initial or rising condition of the drain voltages (i.e., the outputs of the source driver 14) in each of the first and second horizontal lines (in each of the first and second horizontal synchronizing periods) is equalized. This means that the writing condition of the drain voltages in each of the first and second horizontal lines is uniformized. As a result, the total amount of the drain voltages written into the pixels (the area of the hatched regions in Fig. 2) in the first horizontal line is equalized to that in the second horizontal line, which means that the luminance is uniformized, thereby preventing the horizontal stripes from appearing.

[0026]

Moreover, Fig. 3 shows the structure using the latch pulse STB and the polarity pulse POL as the polarity-inverting signal for inverting the polarity of the outputs of the source driver 14. The polarity pulse POL is a signal for ensuring a specific setup time at the rising edge of the latch pulse STB. At the rising edge of the latch pulse STB after the state of the polarity pulse POL is switched, the polarity of the outputs of the source driver 14 is inverted. Accordingly, the initial conditions of the drain voltages for the first and second horizontal lines are equalized by the polarity inversion using the latch pulse STB and the polarity pulse POL also, which means that the writing condition of the drain voltages in each of the first

and second horizontal lines is uniformized. As a result, the total amount of the drain voltages written into the pixels (the area of the hatched regions in Fig. 3) in the first horizontal line is equalized to that in the second horizontal line, which means that the luminance is uniformized, thereby preventing the horizontal stripes from appearing.

[0027]

The relationship between the latch pulse STB and the outputs of the H driver 14 in the cases of Figs. 2 and 3 are shown in Fig. 4. As seen from Fig. 4, the waveforms of the outputs of the H driver 14 in the respective writing periods can be approximately equalized.

[0028]

As explained above, by providing the LCD device with the function of resetting the outputs of the source driver 14 in every horizontal synchronizing period or the function of inverting the polarity of the outputs of the source driver 14 in every horizontal synchronizing period, the initial condition of the drain voltages at their rising edges in each of the first and second horizontal lines is equalized. Thus, the written voltage differences in the first and second horizontal lines are suppressed, which makes it possible to prevent or reduce the horizontal stripes on the screen. Accordingly, a LCD device, where flicker will not be observed even when weak images such as a checkered pattern of dots are displayed, and where no horizontal stripe will appear in every two horizontal lines (every two horizontal synchronizing

periods) when a solid color of a tone is displayed, can be realized.

[0029]

In addition, the polarization inversion of the applied voltages may be carried out in every two or more successive horizontal synchronizing periods. Moreover, the device may be driven according to the 3-H, 4-H, ..., or k-H dot or line inversion method, where $k \geq 3$. In these cases, the same advantages are obtainable by resetting the drain voltages or inverting the polarity of the drain voltages in every horizontal synchronizing period.

[0030]

[Advantages of the Invention]

As explained above, with the LCD device and the method of driving the same, by resetting the outputs of the source driver due to the electrical short-circuit among the positive and negative terminals of the said driver using the latch pulse or the like in a blanking period of each of the horizontal synchronizing periods, or by inverting the polarity of the outputs of the source driver using the polarity pulse or the like in a blanking period of each of the horizontal synchronizing periods, the rising condition of the drain voltages in each horizontal line (in each horizontal synchronizing period) can be uniformized.

[0031]

As a result, the difference between the total amount of the written electric charge in the first horizontal line and that in the

second horizontal line can be suppressed, thereby preventing the horizontal stripes on the screen due to the difference of the written electric charges, which is induced conspicuously if the drain wiring resistance is high.

[0032]

With the LCD device and the method of driving the same, additional advantages are obtainable as follows. The power consumption of the device and method of the invention using the resetting operation is decreased compared with the prior-art device driven by the 1-H inversion method without using the resetting operation. The power consumption of the device and method of the invention using the resetting operation is approximately the same as that of the prior-art device driven by the 2-H inversion method without using the resetting operation.

[0033]

In addition, since the frequency or possibility of flicker itself is reduced, the invention is a measure against the flicker due to the off leak light of TFTs. Accordingly, flicker is rarely observed even when the backlight intensity is high. This means that a high intensity LCD with less flicker can be obtained.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic diagram showing the configuration of a LCD device according to an example of the invention.

[Fig. 2]

Fig. 2 is a diagram showing the waveforms of the drain voltages in the 2-H inversion method where the outputs of the H driver are reset in every horizontal synchronization period according to an example of the invention, and in the prior-art 2-H inversion method for comparison.

[Fig. 3]

Fig. 3 is a diagram showing the waveforms of the drain voltage in the 2-H inversion method where the polarity of the outputs of the H driver is inverted in every horizontal synchronization period according to an example of the invention, and in the prior-art 2-H inversion method for comparison.

[Fig. 4]

Fig. 4 is a diagram showing the waveforms of the outputs of the H driver in the 2-H inversion method according to the example of the invention.

[Fig. 5]

Fig. 5 is a diagram showing the waveforms of the outputs of the H driver in the prior-art 2-H inversion method.

[Fig. 6]

Fig. 6 is a diagram showing the waveforms of the outputs of the H driver in the prior-art 2-H inversion method.

[Fig. 7]

Fig. 7 is a schematic diagram showing the prior-art dot inversion method.

[Fig. 8]

Fig. 8 is a schematic diagram showing the prior-art 2-H dot inversion method.

[Fig. 9]

Fig. 8 is a schematic diagram showing the prior-art 2-H line inversion method.

[Description of Reference Symbols]

10 LCD device

11 LCD panel

12 controller circuit

13 gate driver

14 source driver

15 TFT

16 liquid crystal capacitor

17 scanning line

18 signal line

STB latch pulse

POL Polarity pulse

VCK clock pulse

VOE enable pulse

[Name of Document] Abstract

[Abstract]

[Object]

It is to provide a LCD device that prevents the formation of horizontal stripes without decreasing the luminance, and a method of driving the device.

[Means for Solution]

The LCD device comprises a LCD panel including an active-matrix substrate (which has signal lines, scanning lines, and TFTs), an opposite substrate, and a liquid crystal sandwiched by these substrates; a source driver for driving the signal lines; a gate driver for driving the scanning lines; and a controller circuit for controlling the source driver and the gate driver. The device is driven by a 2-H dot or line inversion method, wherein the outputs of the source driver are reset or the polarity of the outputs of the source driver is inverted, in the blanking period of each horizontal synchronizing period. The rising condition of the drain voltages in each horizontal line (in each horizontal synchronizing period) is uniformized. Thus, the total amount of the written electric charge in the first horizontal line is equalized to that in the second horizontal line, thereby preventing the horizontal stripes from appearing on the screen.

[Selected Figure] Fig. 2

Record of Applicant(s)

Discrimination No.	[000004237]
1. Date of Change	August 29, 1990
[Reason for Change]	Initial Registration
Address	7-1, Shiba 5-chome,
	Minato-ku, Tokyo, Japan
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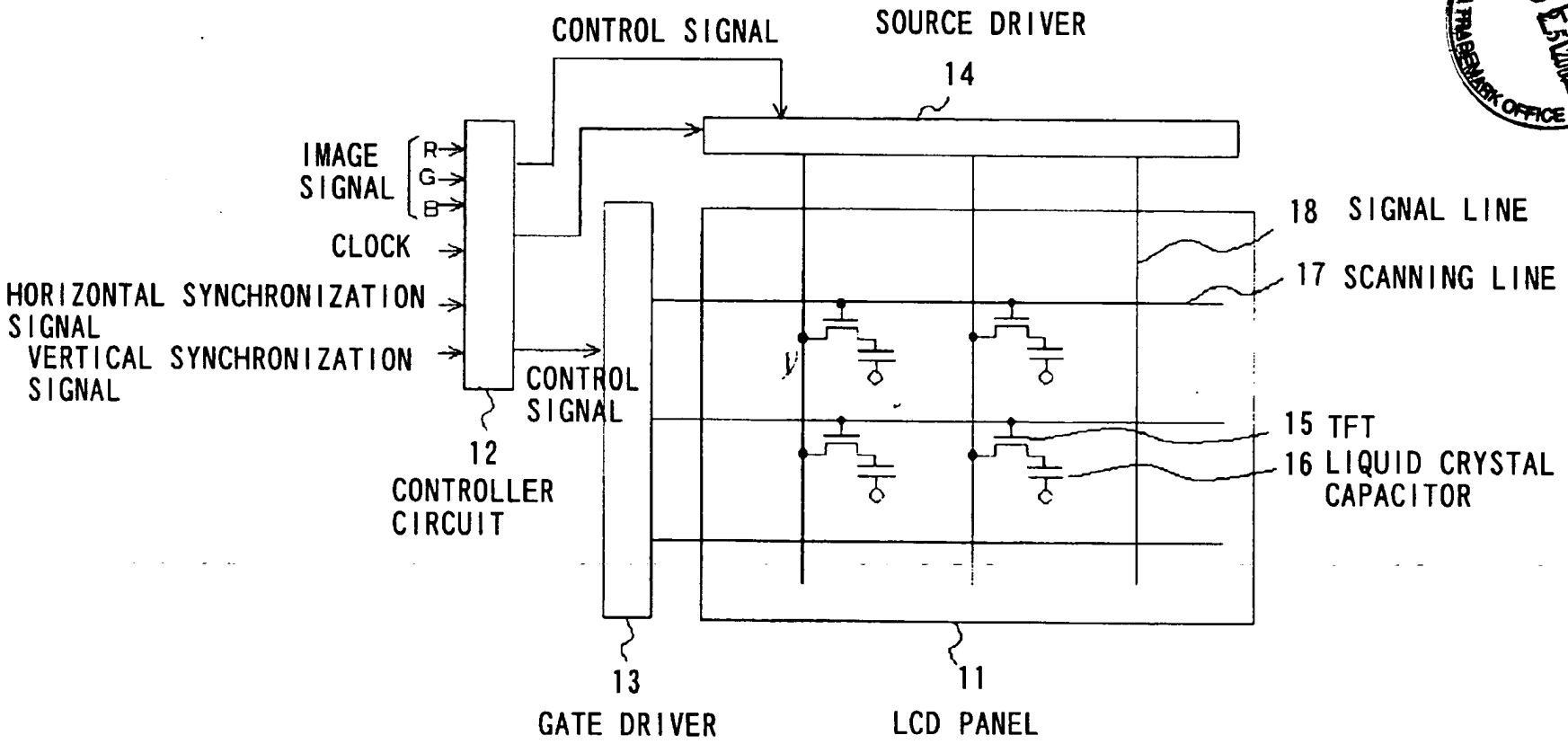
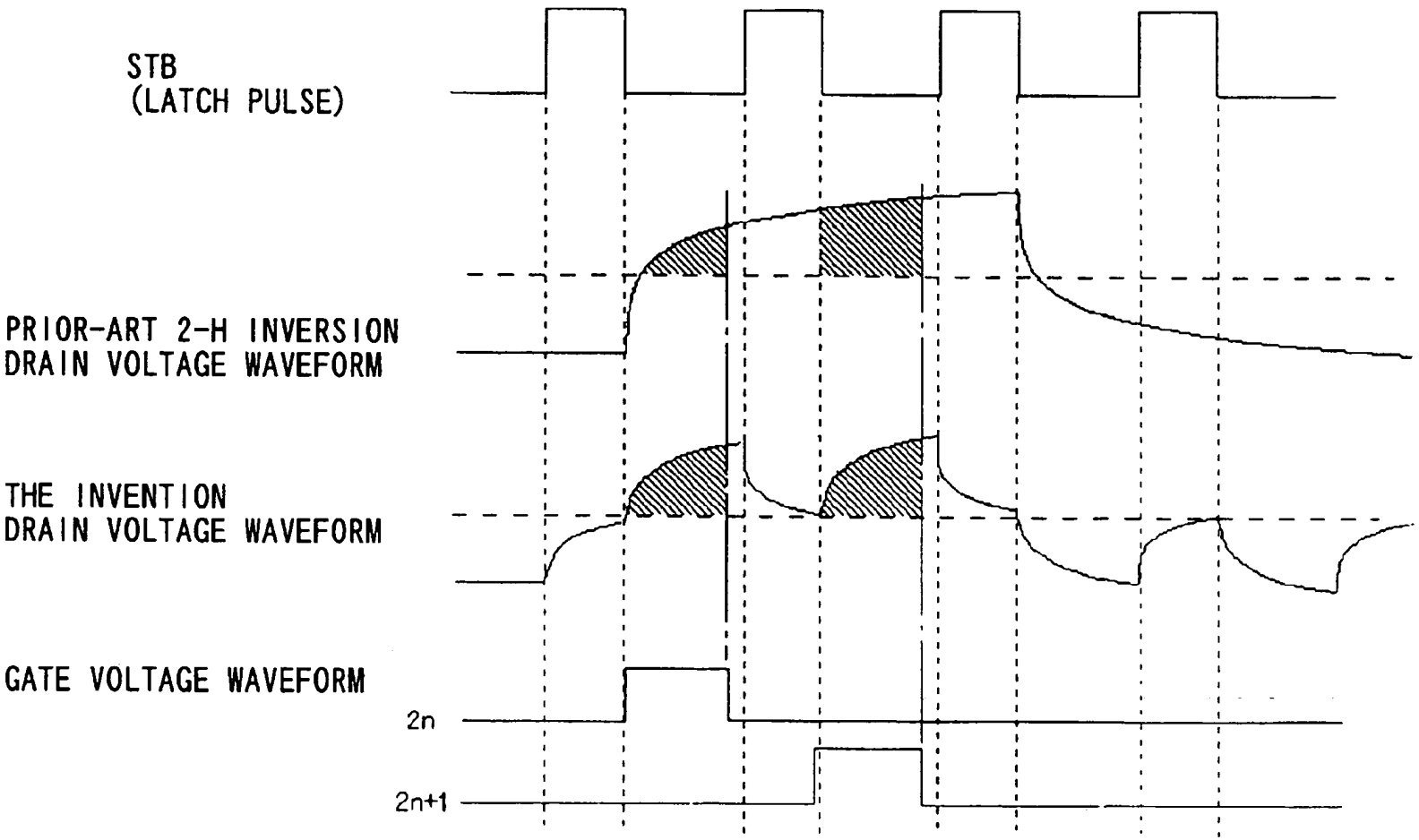
[NAME OF DOCUMENT] DRAWINGS

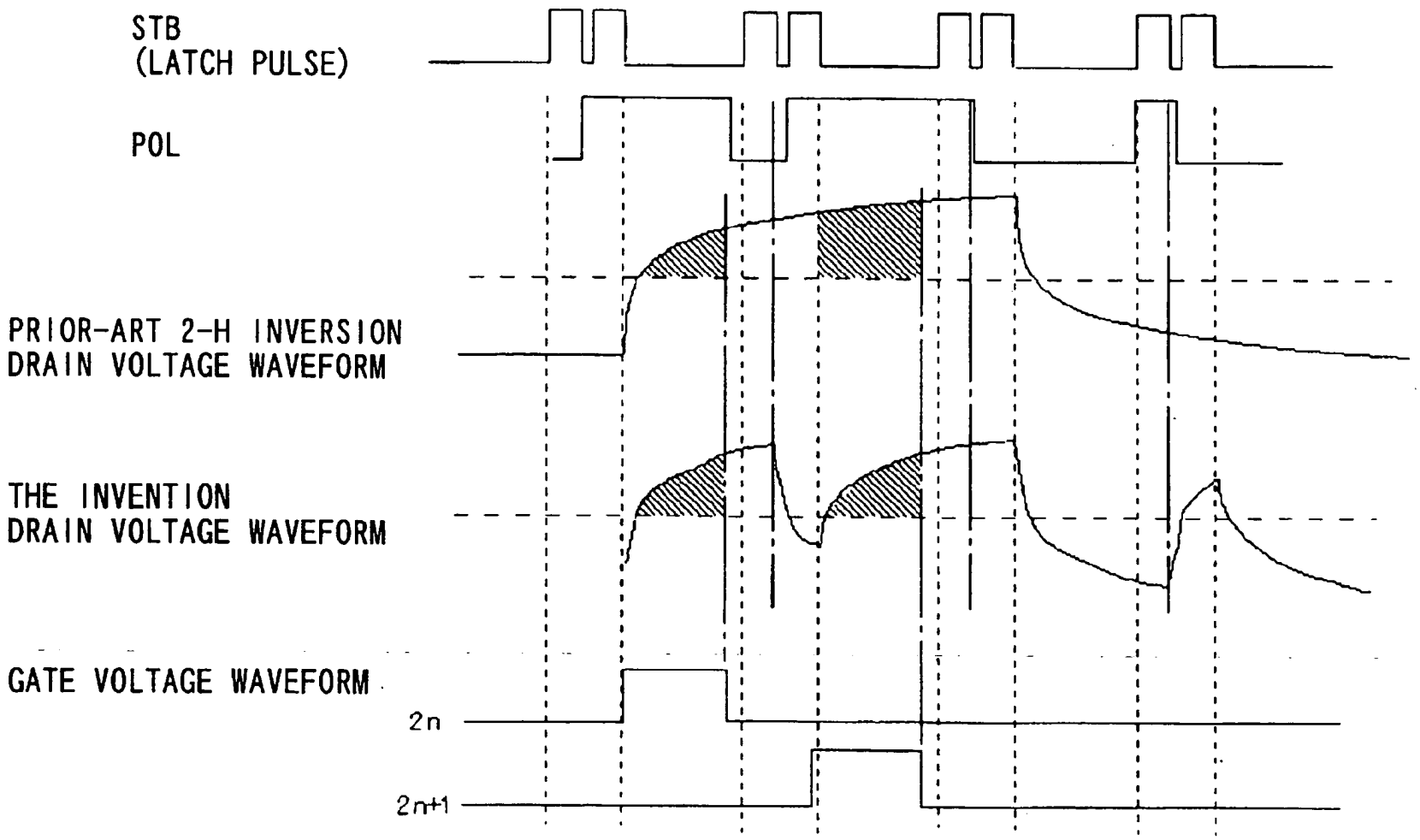
[FIGURE 1]



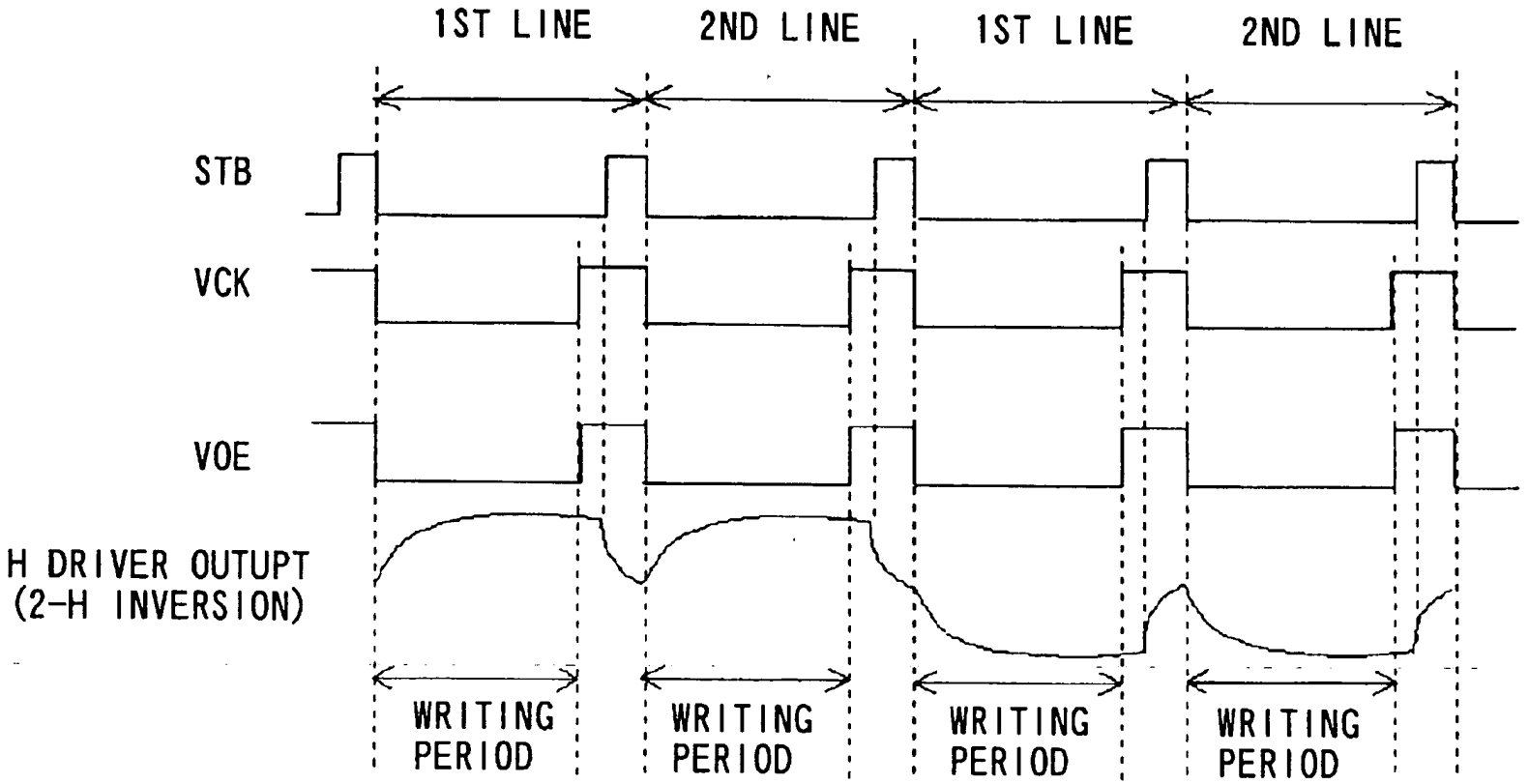
[FIGURE 2]


STB
(LATCH PULSE)
PRIOR-ART 2-H INVERSION
DRAIN VOLTAGE WAVEFORM
THE INVENTION
DRAIN VOLTAGE WAVEFORM
GATE VOLTAGE WAVEFORM
2n
2n+1

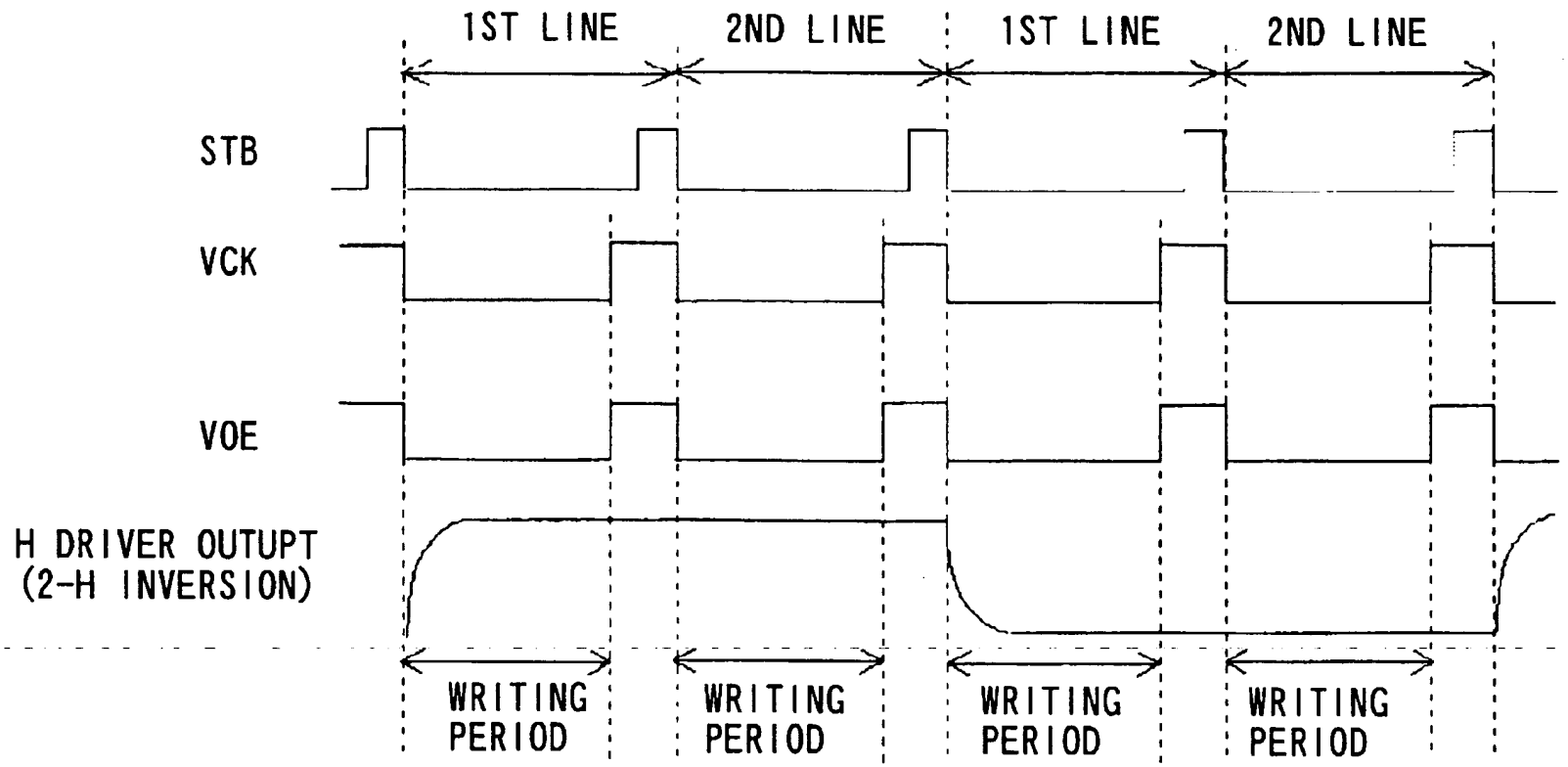
[FIGURE 3]


STB
(LATCH PULSE)
POL
PRIOR-ART 2-H INVERSION
DRAIN VOLTAGE WAVEFORM
THE INVENTION
DRAIN VOLTAGE WAVEFORM
GATE VOLTAGE WAVEFORM
2n
2n+1

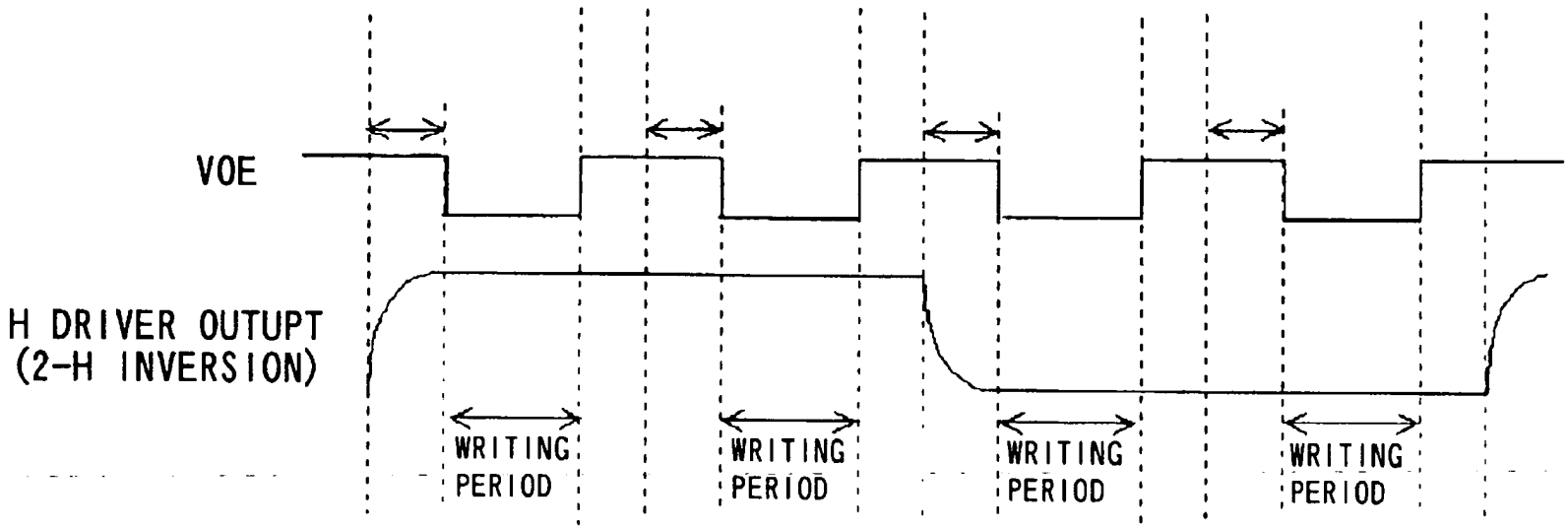
[FIGURE 4]


1ST LINE
2ND LINE
1ST LINE
2ND LINE
STB
VCK
VOE
H DRIVER OUTUPT
(2-H INVERSION)
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD

[FIGURE 5]

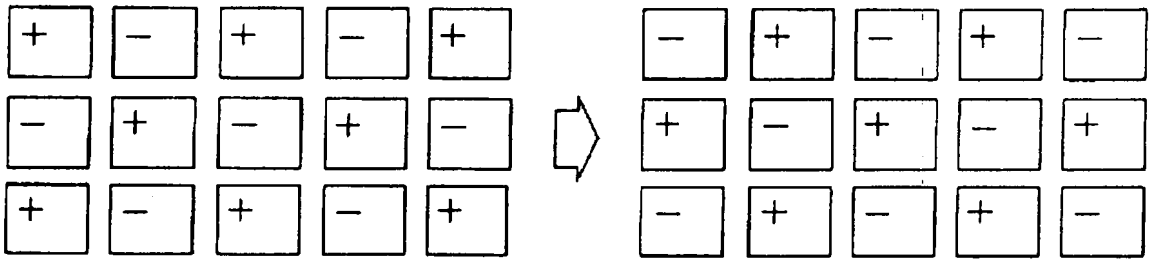

1ST LINE
2ND LINE
1ST LINE
2ND LINE
STB
VCK
VOE
H DRIVER OUTUPT
(2-H INVERSION)
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD

[FIGURE 6]


VOE
H DRIVER OUTUPT
(2-H INVERSION)
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD
WRITING PERIOD

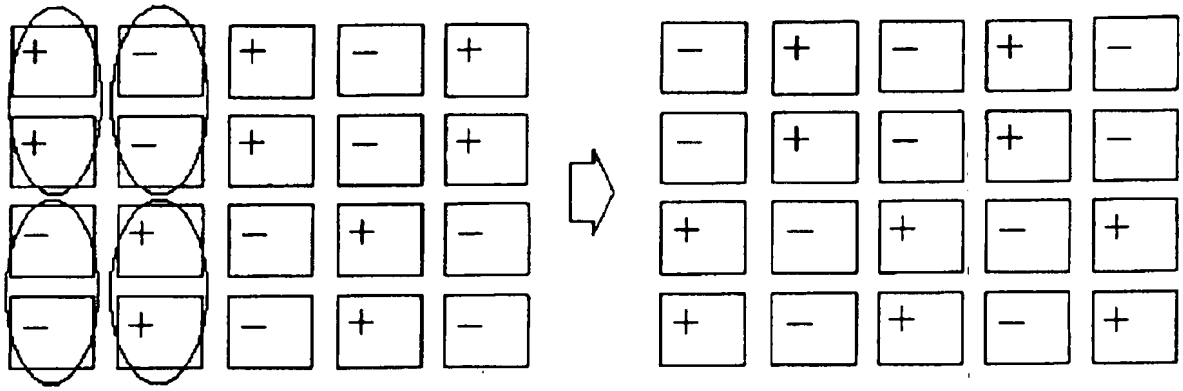
[FIGURE 7]

DOT INVERSION DRIVING



[FIGURE 8]

2-H DOT INVERSION DRIVING



[FIGURE 9]

2-H LINE INVERSION